

Star Formation Studies

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The Center for Star Formation Studies, a consortium of scientists from the Space Science Division at Ames Research Center (ARC) and the Astronomy Departments of the University of California at Berkeley and Santa Cruz, conducts a coordinated program of theoretical research on star and planet formation. The Center supports postdoctoral fellows, senior visitors, and students; meets regularly at Ames to exchange ideas and to present informal seminars on current research; hosts visits of outside scientists; and conducts a summer week-long workshop on selected aspects of star and planet formation.

The main focus of the ARC portion of the research work conducted by the Center during 1997 was on the evolution of the protoplanetary disks which ultimately form planets. In particular, considerable effort was devoted to understanding the effect that nearby massive stars would have on the planet-forming disks around low-mass stars like the Sun, and to the interaction of the young low-mass star with its protoplanetary disk. Many low-mass stars like the Sun form in clusters. When stars form in large clusters, the bulk of the stars are low-mass stars, but a few high-mass stars, 5–100 times as massive as the Sun, also form. These stars are 1000 to 1 million times as luminous as the Sun, and radiate mainly ultraviolet photons.

In collaboration with D. Johnstone (University of Toronto) and J. Bally (University of Colorado), the effect of the ultraviolet radiation of a nearby massive star on young stars with protoplanetary disks was studied. It was found that for young star/disks less than about 1 light year from the massive star, a distance typical of cluster size, the effect of the ultraviolet radiation is quite devastating to planet formation. The irradiated surfaces of the gas and dust disks orbiting the stars are heated to thousands of degrees, and the disks evaporate in timescales of less than a million years, which is shorter than the

timescale thought to be required to accumulate planets. Comparing their models to Hubble Space Telescope observations of 41 such photoevaporating disks in the Orion Nebula, the study group derived disk masses, sizes, lifetimes, and surface-density distributions and explained the optical and infrared spectra seen from these objects.

Disks observed around low-mass young stars which are not disrupted by nearby bright stars are expected to give rise to planetary systems like our own. Together with T. Henning and H. Klahr of the University of Jena (Germany), the midplane conditions in these solar nebula analogs, where solid material from dust to rocks to planetesimals and planets are formed, were studied. That research (which is described more fully in a separate paper in this volume) indicated that because the disk thickness is controlled by the distribution of dust grains, much of the disk may be shadowed from illumination by the central star. Therefore, planet formation occurs in an environment colder than expected by previous estimates.

The theoretical models of ARC have been used to interpret observational data from such NASA facilities as the Infrared Telescope Facility, the Infrared Astronomical Observatory, the Hubble Space Telescope, and the Infrared Space Observatory, a European space telescope with NASA collaboration, as well as data from numerous ground-based radio and optical telescopes. In addition, the models have been used to determine the requirements of future missions such as that of the Stratospheric Observatory for Infrared Astronomy and the proposed Space Infrared Telescope Facility.

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